DRAFT! From Pam Marcum, 16 Feb

Dear colleague,

In January 2015, Paul Hertz (Director, NASA Astrophysics) issued a memo to the astronomical community[1] to stimulate planning for the 2020 Decadal Survey. In the memo, Hertz directed the three Program Analysis Groups[2] (PAG's) to solicit from the astronomical community its discussion of four large (>$1B) mission concepts that were provided by the 2010 Decadal Survey[3] and NASA Visionary Roadmap[4].

- **Far Infrared Surveyor** –This telescope concept would provide an order of magnitude or more performance increase above *Herschel* in one or more of the areas of sensitivity, spectral resolution, and angular resolution.
- **Habitable-Exoplanet Imaging Mission** – This telescope would be capable of direct imaging and spectroscopy of a rocky planet in the habitable zone of a nearby star.
- **UV/Optical/IR Surveyor** – This telescope concept would provide an order of magnitude improvement in sensitivity above the *Hubble Space Telescope*, a wavelength coverage potentially as broad as 10 μm to 91 nm, and carrying one or more instruments for a variety of imaging or spectroscopic measurements.
- **X-ray Surveyor** – This telescope concept would provide as much as two orders of magnitude improvement in sensitivity above *Chandra*. It also potentially could provide improvements in one or more of the parameters of spectral resolution, field of view, or angular resolution.

This list serves as a starting point from which large mission concepts will be funded for study in preparation for the 2020 Decadal Survey. The community is being asked to provide input regarding which large missions should be studied, in order to insure that limited resources for studies are appropriately utilized. Feedback on each of these mission concepts (for example, pros and cons of each mission), including suggested additions or subtractions to the list, is encouraged.

The Cosmic Origins Program Analysis Group (COPAG) invites you to respond to the following survey: a one-to-two page white paper. Participation in this survey is a way to guarantee that your voice will be heard! The survey is only a start: it is meant to

[1] see http://science.nasa.gov/media/medialibrary/2015/01/02/White_Paper_-_Planning_for_the_2020_Decadal_Survey.pdf; see also the presentation given to the PAGs by Paul Hertz: http://cor.gsfc.nasa.gov/copag/aas_jan2015/jan2015-meeting.php

[2] The 3 PAGs are: Exoplanet Exploration (ExoPAG, https://exep.jpl.nasa.gov/exopag/), Cosmic Origins (COPAG, http://cor.gsfc.nasa.gov/copag/) and Physics of the Cosmos (PhysPAG, http://pcos.gsfc.nasa.gov/physpag/)

[3] http://science.nasa.gov/astrophysics/special-events/astro2010-astronomy-and-astrophysics-decadal-survey/

[4] http://science.nasa.gov/media/medialibrary/2013/12/20/secure-Astrophysics_Roadmap_2013.pdf

provoke discussion and debate regarding what the next large mission following JWST and WFIRST should be. There will be future opportunities to provide additional comments on the survey topics. All responses to this survey, unless specifically noted otherwise, will be posted for public reading and to stimulate further discussion.

*(Limit: 2 pages, including figures. Retain Section headings, but remove text associated with instructions)*

## WHITE PAPER TITLE:

## Author(s):

**May your responses be publically posted? (default is "yes" unless otherwise noted):**

### 1. KEY SCIENCE QUESTION(S):

Describe 1-3 important science questions that you think could be addressed by the next large (>$1B) mission, that neither JWST nor WFIRST will be able to definitely answer. Please be as specific as possible by describing specific science *questions* rather than general capabilities or science areas. For example, "Do molecular clouds subjected to extreme environments (turbulence, strong tidal fields, shocks) favor high-mass star formation?" would be more useful than "observing star forming regions at unprecedented angular and spectral resolution" or "investigating high-mass star formation processes". *Feel free to include figures as needed.*

*[replace the above text with your response]*

### 2. TECHNICAL CAPABILITIES:

Describe the performance capabilities (as well as you can) that this mission would require, in order to address the key science. Include the following information (as you are able to, and as is appropriate). *Feel free to include figures as needed.*

- Spectral coverage, e.g. far-UV, UV/visual, near-IR to mid-IR, far-IR?
- Spectral resolving power (both for imaging and spectroscopy)?
- Angular resolution?
- Field of view?
- Primary operational mode, e.g. survey, point-and-stare, etc.?
- Sensitivity? (If you can't answer in a quantitative way, try to describe in terms of the class of object that you would want to be able to detect out to a particular distance, at a desired signal-to-noise ratio).
- Other important capabilities, e.g. multi-object slit spectroscopy, high-contrast coronography, time-resolved photon-counting, etc?

*[replace the above text with your response]*

### 3. A STARTING POINT FOR YOUR CONSIDERATION:

- Comment on whether one of the following four mission concepts would meet the scientific objectives you described in Questions 1-2.
- Please provide feedback on each of the four mission concepts:
  - what are the pros and cons of each mission;
  - which missions should be studied in detail to help determine their suitability for becoming the next large mission, in preparation for the 2020 Decadal;

    - should any of the four missions be removed from consideration for additional study in preparation for the 2020 Decadal?
- Finally, if *none* of the below concepts are a good match to the science objectives you describe above, please state so, and add any description of your different mission concept that hasn't already been captured in your answers to previous questions.

  The four mission concepts provided by past Decadal Surveys and the most recent Roadmap, providing a starting point for consideration for funded studies in preparation for the 2020 Decadal Survey, are:
    - **Far Infrared Surveyor** –This telescope concept would provide an order of magnitude or more performance increase above Herschel in one or more of the areas of sensitivity, spectral resolution, and angular resolution.
    - **Habitable-Exoplanet Imaging Mission** – This telescope would be capable of direct imaging and spectroscopy of a rocky planet in the habitable zone of a nearby star.
    - **UV/Optical/IR Surveyor** – This telescope concept would provide an order of magnitude improvement in sensitivity above the Hubble Space Telescope, a wavelength coverage potentially as broad as 10 μm to 91 nm, and carrying one or more instruments for a variety of imaging or spectroscopic measurements.
    - **X-ray Surveyor** – This telescope concept would provide as much as two orders of magnitude improvement in sensitivity above Chandra. It also potentially could provide improvements in one or more of the parameters of spectral resolution, field of view, or angular resolution.

  *[replace the above text with your response]*

## 4. NEW TECHNOLOGIES:

Would new technologies be required by the large mission you describe above? If so, what new technologies would be required, and what is their current level of maturity (for example, "still in concept formulation", "separate components in test-bed research phase", "an integrated "breadboard" model has been lab-tested", "a prototype is ready for testing in an operational environment"). Specifying in terms of "TRL" is OK, too.

*[replace the above text with your response]*

## 5. LARGE MISSION NEEDED?

Could the science question(s) described above be addressed by a *smaller* mission (Explorer-class, suborbital payloads, etc), or are the science objectives clearly in the realm of a "flagship-sized" mission?